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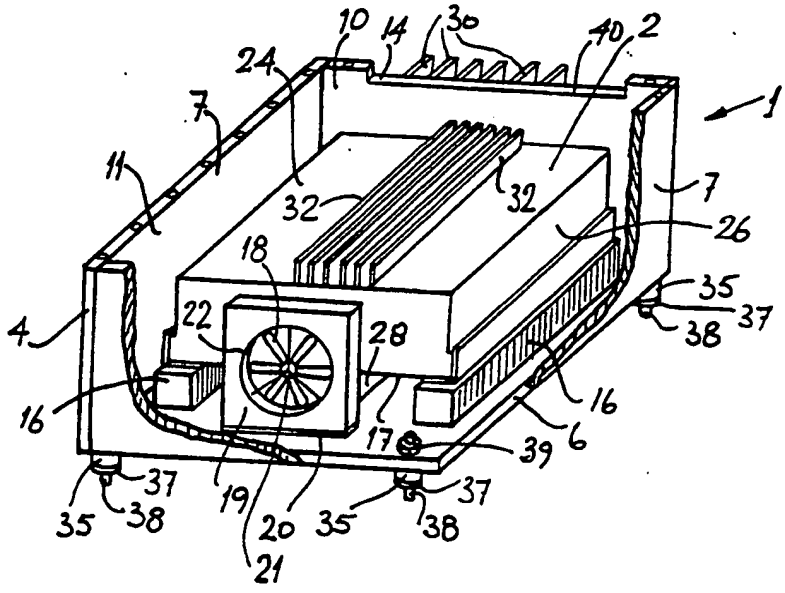

(57) Abstract

Apparatus for damping the transmission of audible noise generated by a disc drive (2) comprises a housing (4) defining a hollow interior region (10) within which the disc drive (2) is mounted on first resilient mounting members (16) for absorbing most of the mechanical vibrations generated by the disc drive (2). Audible noise is absorbed in the housing (4). A blower fan (18) circulates air around the disc drive (2) over first heat exchange fins (28) and third heat exchange fins (32) on the housing (4) and the disc drive (2) for transferring heat from the disc drive (2) to the housing (4). Second heat exchange fins (30) on the housing (4) dissipate heat from the housing (4).

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"Apparatus for damping the transmission of audible noise generated by a disc drive"

The present invention relates to apparatus for damping the transmission of audible noise generated by a disc drive of a computer or other computer type device. The invention also relates to the apparatus comprising the disc drive, and the invention relates to a computer comprising the apparatus. Further, the invention relates to a method for damping the transmission of audible noise generated by a disc drive.

Hard disc drives in computers tend to generate a relatively high degree of audible noise, which is caused by mechanical vibrations in the disc drive. The mechanical vibrations generate acoustic audible noise which is transmitted from the disc drive through the air medium surrounding the disc drive. The mechanical vibrations are also transmitted into a cabinet, such as, a computer cabinet, in which or on which the disc drive is mounted, thus generating acoustic audible noise in the cabinet, which is likewise transmitted through the air medium surrounding the cabinet. By virtue of the construction of such cabinets and the mounting arrangement of the disc drive in such cabinets, the audible noise generated by the disc drive and in the cabinet, in general, is significantly amplified by the cabinet. The mechanical vibrations are generated by the motor drive of the disc drive, and the related transmission which drives the disc. Additionally, the drive transmission for positioning the read/write head during read and write actions also generates mechanical vibrations which contribute to the audible noise. In general, the mechanical vibrations generated by the motor drive and related transmission are generated continuously while the computer is powered up. It has been found that such disc drive generated audible noise has significant adverse effects on operatives working with computers.

There is therefore a need for apparatus for damping the

transmission of audible noise generated by a disc drive of a computer. There is also a need for the apparatus when containing the disc drive, and a computer comprising the apparatus. Additionally, there is a need for a method for damping the transmission of audible noise generated by a disc drive.

It is an object of the invention to provide apparatus for damping the transmission of audible noise generated by a disc drive of a computer. It is also an object of the invention to provide such an apparatus comprising a disc drive, and it is further an object of the invention to provide a computer comprising the apparatus. It is also an object of the invention to provide a method for damping the transmission of audible noise generated by a disc drive.

According to the invention there is provided apparatus for damping the transmission of audible noise generated by a disc drive of a computer or other computer type device, wherein the apparatus comprises a substantially closed housing having an outer surface and an inner surface, the inner surface defining a hollow interior region for housing the disc drive, a first vibration damping mounting means for mounting the disc drive in the hollow interior region spaced apart from the inner surface of the housing, and a blower means for circulating a fluid medium in the hollow interior region for transfer of heat from the disc drive to the housing.

The apparatus according to the invention has many advantages. The main advantage of the invention is that audible noise generated by a disc drive, and in particular, a hard disc drive is damped to such an extent, that the noise is barely audible to an operator using the computer with which the disc drive is associated. The first vibration damping mounting means absorbs a significant amount of mechanical vibrations generated by the disc drive which result in audible noise. Thereby, the generation of acoustic audible noise in the housing by such mechanical

vibrations is substantially eliminated. The acoustic audible noise generated in the disc drive by the mechanical vibrations is contained within and absorbed in the housing. A further advantage of the invention is that the first vibration damping mounting means also protects the disc drive from external mechanical vibrations, shocks and the like caused by careless handling and otherwise. The blower means by circulating a fluid medium, typically, air in the hollow interior region, transfers heat from the disc drive to the housing. This avoids overheating of the disc drive, and furthermore, in general, provides a controlled environment within the hollow interior region, and in general, the temperature is maintained substantially stable and relatively even within the hollow interior region. The temperature within the hollow interior region, in general, is slow to rise, and slow to fall. This significantly enhances the life and reliability of the disc drive.

In one embodiment of the invention a first heat exchange means is mounted in the housing extending into the hollow interior region from the inner surface for transferring heat from the fluid medium to the housing.

In another embodiment of the invention a second heat exchange means is mounted on the housing extending outwardly therefrom from the outer surface of the housing for transferring heat from the housing.

Preferably, each heat exchange means comprises a plurality of spaced apart heat exchange fins of heat conductive material.

In another embodiment of the invention the blower means circulates the fluid medium in the hollow interior region around the disc drive between the disc drive and the inner surface of the housing. The advantage of this feature of the invention is that the temperature of the disc drive is maintained relatively stable.

In another embodiment of the invention the blower means is mounted in the hollow interior region of the housing. Preferably, the blower means comprises a blower fan. Advantageously, the blower fan is powered by an electric motor. Preferably, the electric motor is mounted in the hollow interior region of the housing. Typically, the blower fan and electric motor are provided as an integral unit.

Advantageously, a second vibration damping mounting means is provided for mounting the blower means to the housing. The advantage of providing the second vibration damping mounting means for mounting the blower means to the housing is that any mechanical vibrations generated by the blower means are damped and substantially absorbed by the second vibration damping mounting means, thereby, at least minimising the transfer of such mechanical vibrations to the housing, and preferably, preventing the transfer of such mechanical vibrations to the housing.

In one embodiment of the invention the second vibration damping mounting means is mounted in the hollow interior region.

Advantageously, the first vibration damping mounting means is mounted in the hollow interior region.

Preferably, each vibration damping mounting means comprises an elastic mounting means. Advantageously, each elastic mounting means comprises a resilient material.

In another embodiment of the invention a third heat exchange means is mounted on the disc drive for transferring heat from the disc drive to the fluid medium. Typically, the third heat exchange means comprises a plurality of spaced apart heat exchange fins of heat conductive material.

In a further embodiment of the invention a ribbon cable accommodating opening is provided in the housing extending from

the outer surface to the inner surface for accommodating a ribbon cable into the hollow interior region.

Advantageously, the housing comprises a base, a pair of spaced apart side walls extending upwardly from the base joined by a pair of spaced apart end walls extending upwardly from the base, and a top wall extending between the side and end walls to define with the side and end walls, and the base the hollow interior region.

In one embodiment of the invention each vibrating damping mounting means is mounted on the base. Preferably, the first heat exchange means is mounted on the base. Advantageously, the ribbon cable accommodating opening is formed by an elongated slot in one of the end walls adjacent the top wall.

In another embodiment of the invention a third vibration damping mounting means extends from the outer surface of the housing for supporting the housing. The advantage of providing a third vibration damping mounting means is that any residual mechanical vibrations in the housing are damped and absorbed by the third vibration damping mounting means to prevent their transmission into a computer housing or cabinet or the like in which the housing is mounted.

In another embodiment of the invention the housing is of relatively high mass. Where the housing is of a relatively high mass further absorbtion of audible noise and mechanical vibrations generated by the disc drive and/or blower means are absorbed in the housing. An additional advantage of providing the housing of a relatively high mass is that additional protection of the disc drive is provided. The disc drive is further protected against the effects of external vibrations, shocks and the like.

Advantageously, the housing comprises a heat conductive material

to facilitate dissipation of heat from the disc drive to atmosphere.

In another embodiment of the invention the housing comprises a material having electromagnetic waves shielding properties for shielding the disc drive from external electromagnetic waves.

In a further embodiment of the invention the housing comprises a material having magnetic field shielding properties for shielding the disc drive from external magnetic fields.

Preferably, the housing is a closed housing. Where the housing is completely closed transmission of acoustic audible noise from the disc drive is virtually totally contained within and blocked by the housing. Additionally, the hollow interior region provides an effectively dust free environment which further enhances the life and reliability, as well as the working accuracy of the disc drive. The provision of a closed housing also enables the humidity within the hollow interior region to be controlled, thereby further enhancing the life, reliability and working accuracy of the disc drive.

In one embodiment of the invention a disc drive is mounted in the hollow interior region of the housing on the first vibration damping mounting means. In another embodiment of the invention the disc drive is a hard disc drive.

Additionally, the invention provides a computer comprising a computer cabinet and a disc drive mounted in the computer cabinet, wherein the apparatus according to the invention is mounted within the computer cabinet, and the disc drive is mounted in the hollow interior region of the housing of the apparatus on the first vibration damping mounting means.

Additionally the invention provides a method for damping the transmission of audible noise generated by a disc drive of a

computer or other computer type device, wherein the method comprises the steps of placing the disc drive in a hollow interior region of a substantially closed housing with the disc drive mounted on first vibration damping mounting means within the hollow interior region, and spaced apart from an inner surface of the housing defining the hollow interior region, and circulating a fluid medium in the hollow interior region of the housing for transferring heat from the disc drive to the housing.

The invention will be more clearly understood from the following description of a preferred embodiment thereof given by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of apparatus according to the invention for damping the transmission of audible noise generated by a disc drive,

Fig. 2 is a perspective view of portion of the apparatus of Fig. 1,

Fig. 3 is a cut-away perspective view of portion of the apparatus of Fig. 1,

Fig. 4 is a cut-away perspective view of the portion of the apparatus in Fig. 3 in use,

Fig. 5 is a cross-sectional side elevational view of the apparatus of Fig. 1,

Fig. 6 is a cross-sectional end elevational view of the apparatus of Fig. 1 on the line VI - VI of Fig. 5,

Fig. 7 is a cross-sectional end elevational view of the apparatus of Fig. 1 on the line VII - VII of Fig. 5, and

Fig. 8 is a perspective view of portion of the apparatus of Fig. 1.

Referring to the drawings there is illustrated apparatus according to the invention indicated generally by the reference numeral 1 for damping the transmission of audible noise generated by a hard disc drive 2 of, for example, a computer (not shown). The hard disc drive 2 is illustrated in block representation. The apparatus 1 comprises a substantially closed housing 4 of relatively high mass comprising a base 6, a pair of spaced apart parallel side walls 7 extending upwardly from the base 6 and joined by spaced apart parallel end walls 8 also extending upwardly from the base 6. A top wall 9 parallel to the base 6 extends between the side walls 7 and the end walls 8, and defines with the side walls 7, end walls 8 and base 9, a hollow interior region 10 for housing the disc drive 2. Inner surfaces of the base 6, side walls 7, end walls 8 and top wall 9 form an inner surface 11 of the housing 4 which defines the hollow interior region 10, and outer surfaces of the base 6, side walls 7, end walls 8 and top wall 9 form an outer surface 12 of the housing 4. Screws 13 secure the top wall 9 to the side and end walls 7 and 8, respectively. The base 6, side walls 7, end walls 8 and top wall 9 are of steel plate material, and are preferably, of 5 mm thickness to provide a housing 4 of relatively high mass for absorbing acoustic audible noise generated by the disc drive 2, and also to facilitate absorbtion and dissipation of heat generated by the disc drive 2. By providing the housing of steel plate material, the housing has electromagnetic wave and magnetic field shielding properties for shielding the disc drive 2 from the effects of external electromagnetic waves and also from the effects of external magnetic fields. A ribbon accommodating opening for accommodating a ribbon cable (not shown) into the hollow interior region 10 for connection to the disc drive 2 and other components (described below) in the hollow interior region 10 is formed by a slot 14 in one of the end walls 8 and between the end wall 8 and the top wall 9.

First vibration damping mounting means for mounting the disc drive 2 in the hollow interior region 10 spaced apart completely from the inner surface 11 of the housing 4 comprises an elastic mounting formed by a pair of spaced apart parallel elongated first resilient mounting members 16 of a resilient plastics material, typically, synthetic foam rubber. The first resilient mounting members 16 are of square cross-section and extend substantially the length of the disc drive 2 parallel to the side walls 7. However, the first resilient mounting member 16 are shorter than the side walls 7, and stop short of, and are spaced apart from the end walls 8. The first resilient mounting member 16 are secured to the base by bonding using a suitable adhesive, and are secured to a base 17 of the disc drive 2 adjacent opposite side edges thereof also by bonding with a suitable adhesive. The first resilient mounting members 16 significantly dampen the transmission of mechanical vibrations of the type which generate audible noise from the disc drive 2 into the housing 4, and accordingly, in general, absorb and virtually completely prevent the transmission of such mechanical vibrations into the housing 2.

Blower means for circulating a fluid medium, namely, air in the hollow interior region 10 around the disc drive 2 for transferring heat from the disc drive 2 to the housing 4 comprises a blower fan 18 illustrated in block representation mounted in a fan housing 19 mounted in the hollow interior region 10. Second vibration damping mounting means comprising a second elastic mounting formed by a second elongated resilient mounting member 20 mounts the fan housing 19 on the base 6. The second mounting member 20 is of rectangular cross-section of a similar type resilient plastics material to the first mounting member 16 and extends substantially the length of the fan housing 19. A suitable adhesive bonds the second mounting member 20 to the base 6 and the fan housing 19. An electrically powered motor 21 is provided in the fan housing 19 for driving the blower fan 18. Accordingly, all mechanical vibrations generated by the blower

fan 18 and the motor 21 are transmitted into the second mounting member 20 where they are dampened and absorbed. Any acoustic audible noise generated by the blower fan 18 and the motor 21 is contained within and absorbed by the housing 4. The fan housing 19 is provided with an air inlet 22 and an air outlet 23 through which air is drawn and delivered, respectively, by the blower fan 18. The fan housing 19 is mounted in the interior region 10 so that air is circulated around the disc drive 2 in the direction of the arrows A, namely, in one direction between the respective bases 6 and 17 of the housing 4 and the disc drive 2, and a top 24 of the disc drive 2 and the top wall 9, and returned between an end 25 of the disc drive 2 and one of the end walls 8 of the housing 4 and between sides 26 of the disc drive 2 and the side walls 7, thereby maintaining the temperature throughout the hollow interior region 10 relatively even and stable. Electrical power is provided to the motor 21 in the fan housing 19 through cables (not shown) which are passed into the interior region 10 through the slot 14. The cables to the electric motor may be included in the ribbon cable.

First heat exchange means comprising six spaced apart parallel elongated first heat exchange fins 28 of heat conductive material, namely, steel, are mounted on the base 6 and extend into the hollow interior region 10 from the inner surface 11 of the base 6 for transferring heat from the circulating air generated by the disc drive 2 and in turn conducting the heat into the housing 4. The first heat exchange fins 28 are provided between the first mounting members 16 and extend parallel thereto and are of a height from the base less than the height of the first mounting member 16 from the base so that top longitudinal edges 29 stop short and are spaced apart from the base 17 of the disc drive 2 to avoid any danger of mechanical vibrations and audible noise being transferred from the disc drive 2 into the housing 4 through the first heat exchange fins 28. The first heat exchange fins 28 are arranged so that air being circulated by the blower fan 18 passes along between and over the first heat

exchange fins 28.

Second heat exchange means comprising two banks, each comprising four spaced apart parallel elongated second heat exchange fins 30 of heat conductive material, namely, steel are mounted on one of the end walls 8 of the housing 4 and extend from the outer surface 12 thereof for dissipating heat from the housing 4. In this embodiment of the invention the second heat exchange fins 30 are provided on the end wall 8 in which the slot 14 is formed, and which is remote from the blower fan 18.

Third heat exchange means comprising six spaced apart parallel elongated third heat exchange fins 32 of heat conductive material, namely steel are mounted on and extend from the top 24 of the disc drive 2 for further facilitating the transfer of heat from the disc drive 2 to the circulating air for subsequent transfer into the housing 4. The third heat exchange fins 32 extend substantially parallel to the side walls 7 and extend approximately the length of the disc drive housing 2. The third heat exchange fins 32 extend to a height from the top 24 of the disc drive 2 short of the top wall 9 to ensure that the third heat exchange fins 32 do not engage the top wall 9 to avoid the transfer of audible noise and mechanical vibrations from the disc drive 2 into the housing 4 through the heat exchange fins 32. Clips (not shown) secure the third heat exchange fins 32 to the disc drive 2, and a thermal transfer compound is provided between the third heat exchange fins 32 and the disc drive 2 to facilitate efficient heat transfer into the third heat exchange fins 32.

Third vibration damping mounting means for mounting the housing 4 in a cabinet (not shown) of the computer (also not shown) comprises four resilient mounting brackets 35 mounted on the base 6 and extending downwardly from the outer surface 12. The mounting brackets 35 damp and absorb any residual mechanical vibrations from the disc drive 2, the blower fan 18 and the motor

21, which may not have been fully absorbed by the first and second mounting members 16 and 20 and the housing 4 to avoid transmission of such mechanical vibrations to the computer cabinet. Each mounting bracket 35 comprises a circular block 36 of resilient natural rubber material which is sandwiched between and bonded to a pair of circular mounting plates 37. Screws 38 extend from the mounting plates 37 for engaging holes (not shown) in the base 6 of the housing 4 and corresponding holes in the computer cabinet (not shown). Nuts 39 secure the screws 38 in the base 6. The natural rubber material of the blocks 36 is a relatively harder material than the synthetic foam rubber material of the mounting members 16 and 20, due to the fact that the mounting brackets 35 carry the entire weight of the apparatus 1 and the disc drive 2.

A sealing strip (not shown) is provided for sealing any gaps between the ribbon cable (also not shown) and a peripheral edge 40 of the slot 14. Such sealing strip, may be secured around the peripheral edge 40, or may be provided by a sealing compound injected between the peripheral edge 40 of the slot 14 and the ribbon cable after the ribbon cable has been passed through the slot 14.

In use, with the hard disc drive 2 mounted on the first mounting member 16 in the hollow interior region 10, a ribbon cable (not shown) for powering and controlling the disc drive is connected to the disc drive and the cables for powering the motor 21 of the blower fan 18 are connected to the motor 21. The ribbon cable is located in the slot 14, and the top wall 9 is secured by the screws 13 to the side and end walls 7 and 8. If a sealing member is not provided around the peripheral edge 40 of the slot 14, a suitable sealing compound, such as a mastic, is injected between the ribbon cable and the peripheral edge 40 of the slot 14. The housing 4 is then located and secured in a computer cabinet using the mounting brackets 35. Alternatively, the housing 4 may be mounted in a computer cabinet by other suitable mounting means or

may be mounted in any other cabinet, and indeed, in certain cases, if it is desired the housing 4 may be provided as a stand alone housing, in which case, suitable resilient mounting pads, may be secured to the base 6 instead of the mounting brackets 35. The ribbon cable is connected to the appropriate port or ports in the computer. The computer is operated in conventional fashion. While the disc drive 2 is operating, in other words, once the computer is powered up, the fan blower 18 is driven by the electric motor and continuously circulates air around the disc drive 2 within the hollow interior region 10. Heat generated by the disc drive 2 is transferred by convection, conduction and radiation to the housing 4. The heat transfer is facilitated by the first and third heat exchange fins 28 and 32. The heat is dissipated from the housing 4 through the second heat exchange fin 30. Substantially all mechanical vibrations generated by the disc drive 2, the fan blower 18 and the electric motor 21 are absorbed in the first and second resilient mounting members 16 and 20. Acoustic audible noise is contained within and absorbed and blocked by the housing 4. Should any residual mechanical vibrations be present in the housing 4, these, in general, are absorbed by the mounting brackets 35.

It is envisaged that in certain cases detecting means for detecting the operation of the disc drive 2 may be provided in the hollow interior region 10, and indicating means may be provided externally of the housing 4 to indicate to a user that the disc drive 2 is operating. The detecting means and the indicating means would be connected by, for example, the ribbon cable. Such detecting means may comprise a microphone which would detect the noise of the disc drive. The indicating means may be an amplifier and loud speaker, the volume of which would be adjustable to provide a relatively low hum indicating operation of the disc drive. Such a low hum would be of sufficiently low level of volume as not to adversely effect the performance of an operator of a computer or other such device containing the apparatus. Alternatively, and in many cases,

preferably, a visual indicating means, for example, a light, neon indicator or the like responsive to the microphone would be provided on a display panel on the computer. Needless to say, other detecting means besides a microphone, for example, a vibration detector or the like may be provided. Other detecting means for example, detecting means for detecting the temperature humidity and other parameters of the air within the hollow interior region 10 and the disc drive may be provided and suitable indicating means would likewise be provided externally of the housing, for example, on a display panel on the computer for indicating the status of the relevant parameters to an operator.

It is envisaged that in certain cases the fan blower, instead of being mounted to the housing may be mounted directly onto the disc drive. In such cases, it will be appreciated that the second vibration damping mounting means may be dispensed with, since any mechanical vibrations generated by the blower fan and motor would be damped and absorbed by the first vibration damping mounting means.

While the housing has been described as being of particular shape and construction, other shapes and construction of housing may be provided. Further, while the housing has been described as being a relatively high mass housing, while this is preferable it is not essential. Additionally, it is envisaged in certain cases that the housing may be of material other than steel, for example, the housing may be of other suitable or desirable metals, such as, aluminium, or metal alloys, the housing may also be of a plastics material, or indeed, any other suitable or desirable materials. However, from the point of view of dissipating heat generated by the disc drive, it is preferable that the housing should be of a material with relatively good heat conductive properties. It is also preferable that the housing should be of steel or other suitable materials with good magnetic field and electromagnetic wave shielding properties in

order to protect the disc drive from the effects of external magnetic fields and/or electromagnetic waves.

Needless to say, any other suitable construction and arrangement or type of vibration damping mounting means may be provided for mounting the disc drive and the fan blower in the housing.

Other suitable heat exchange means may be provided, and in certain cases, it is envisaged that some or all of the heat exchange means may be omitted. It is also envisaged that more heat exchange means may be provided, for example, heat exchange fins or other suitable heat exchange means may be provided on the inner surface of some or all of the walls of the housing extending inwardly into the hollow interior region, and if desired, heat exchange fins or other suitable heat exchange means may be provided on the outer surface of some or all of the walls of the housing. Additionally, a greater or lesser number of heat exchange fins may be provided on the housing and the disc drive.

Additionally, while two first resilient mounting members have been described, the disc drive may be mounted on any desired number of resilient mounting members, indeed, in certain cases, it is envisaged that one resilient mounting member may be sufficient. Needless to say, any suitable number of resilient mounting members may be provided for resiliently mounting the fan blower housing.

While four mounting brackets extending from the base of the housing have been described for mounting the housing to a computer cabinet, any other desired number of mounting brackets may be provided, indeed in certain cases other suitable third vibration damping mounting means may be used. It will also be appreciated that in certain cases the mounting brackets may be omitted. Indeed, in certain cases it is envisaged that the housing may be mounted directly onto a wall or base of the

computer housing without the need for third resilient mounting means.

In certain cases, it is envisaged that the disc drive and/or the fan blower may be suspended from the top and/or side walls by suitable elastic mounting means.

While the apparatus has been described for housing a hard disc drive, the apparatus may be used for any other type of disc drive, for example, a floppy disc drive, a micro disc drive or the like. In such cases, the housing of the apparatus would be provided with a disc accommodating slot. Such slot, could be arranged to be releasably sealably closed during operation of the disc drive.

Additionally, it is envisaged that other means for attaching the heat exchange fins to the disc drive may be provided, and indeed, in certain cases, the disc drive may be provided with heat exchange fins integrally formed thereon. It will also be appreciated that the first and second heat exchange means may be mounted to the housing by any suitable means, and in certain cases, may be formed integrally with the housing.

While the material of the housing has been described as being of a particular thickness, materials of other thickness may be provided. However, it is desirable that the material of the housing should be of a thickness in the range of 0.6 mm to 8 mm, and preferably, the thickness of the material of the housing should be in the range of 1 mm to 6 mm.

CLAIMS

1. Apparatus for damping the transmission of audible noise generated by a disc drive (2) of a computer or other computer type device, characterised in that the apparatus (1) comprises a substantially closed housing (4) having an outer surface (12) and an inner surface (11), the inner surface (11) defining a hollow interior region (10) for housing the disc drive (2), a first vibration damping mounting means (16) for mounting the disc drive (2) in the hollow interior region (10) spaced apart from the inner surface (11) of the housing (4), and a blower means (18,19) for circulating a fluid medium in the hollow interior region (10) for transfer of heat from the disc drive (2) to the housing (4).

2. Apparatus as claimed in Claim 1 characterised in that a first heat exchange means (28) is mounted in the housing (4) extending into the hollow interior region (10) from the inner surface (11) for transferring heat from the fluid medium to the housing (4).

3. Apparatus as claimed in Claim 1 or 2 characterised in that a second heat exchange means (30) is mounted on the housing (4) extending outwardly therefrom from the outer surface (12) of the housing (4) for transferring heat from the housing (4).

4. Apparatus as claimed in Claim 2 or 3 characterised in that each heat exchange means (28,30) comprises a plurality of spaced apart heat exchange fins (28,30) of heat conductive material.

5. Apparatus as claimed in any preceding claim characterised in that the blower means (18,19) circulates the fluid medium in the hollow interior region (10) around the disc drive (2) between the disc drive (2) and the inner surface (11) of the housing (4).

6. Apparatus as claimed in any preceding claim characterised in that the blower means (18,19) is mounted in the hollow interior region (10) of the housing (4).

7. Apparatus as claimed in any preceding claim characterised in that the blower means (18,19) comprises a blower fan (18).

8. Apparatus as claimed in Claim 7 characterised in that the blower fan (18) is powered by an electric motor (21).

9. Apparatus as claimed in Claim 8 characterised in that the electric motor (21) is mounted in the hollow interior region (10) of the housing (4).

10. Apparatus as claimed in Claim 8 or 9 characterised in that the blower fan (18) and electric motor (21) are provided as an integral unit.

11. Apparatus as claimed in any preceding claim characterised in that a second vibration damping mounting means (20) is provided for mounting the blower means (18) to the housing (4).

12. Apparatus as claimed in Claim 11 characterised in that the second vibration damping mounting means (20) is mounted in the hollow interior region (10).

13. Apparatus as claimed in any preceding claim characterised in that the first vibration damping mounting means (16) is mounted in the hollow interior region (10).

14. Apparatus as claimed in any preceding claim characterised in that each vibration damping mounting means (16,20) comprises an elastic mounting means (16,20).

15. Apparatus as claimed in Claim 14 characterised in that each elastic mounting means (16,20) comprises a resilient material.

16. Apparatus as claimed in any preceding claim characterised in that a third heat exchange means (32) is mounted on the disc drive (2) for transferring heat from the disc drive (2) to the

fluid medium.

17. Apparatus as claimed in Claim 16 characterised in that the third heat exchange means (32) comprises a plurality of spaced apart heat exchange fins (32) of heat conductive material.

18. Apparatus as claimed in any preceding claim characterised in that a ribbon cable accommodating opening (14) is provided in the housing (14) extending from the outer surface (12) to the inner surface (11) for accommodating a ribbon cable into the hollow interior region (10).

19. Apparatus as claimed in any preceding claim characterised in that the housing (4) comprises a base (6), a pair of spaced apart side walls (7) extending upwardly from the base (6) joined by a pair of spaced apart end walls (8) extending upwardly from the base (6), and a top wall (9) extending between the side and end walls (7,8) to define with the side and end walls (7,8), and the base (6) the hollow interior region (10).

20. Apparatus as claimed in Claim 19 characterised in that each vibrating damping mounting means (16,20) is mounted on the base (6).

21. Apparatus as claimed in Claim 19 or 20 characterised in that the first heat exchange means (28) is mounted on the base (6).

22. Apparatus as claimed in any of Claims 19 to 21 characterised in that the ribbon cable accommodating opening (14) is formed by an elongated slot (14) in one of the end walls (8) adjacent the top wall (9).

23. Apparatus as claimed in any preceding claim characterised in that a third vibration damping mounting means extends (35) from the outer surface (12) of the housing (4) for supporting the housing (4).

24. Apparatus as claimed in any preceding claim characterised in that the housing (4) is of relatively high mass.

25. Apparatus as claimed in any preceding claim characterised in that the housing (4) comprises a heat conductive material.

26. Apparatus as claimed in any preceding claim characterised in that the housing (4) comprises a material having electromagnetic waves shielding properties for shielding the disc drive from external electromagnetic waves.

27. Apparatus as claimed in any preceding claim characterised in that the housing (4) comprises a material having magnetic field shielding properties for shielding the disc drive from external magnetic fields.

28. Apparatus as claimed in any preceding claim characterised in that the housing (4) is a closed housing (4).

29. Apparatus as claimed in any preceding claim characterised in that a disc drive (2) is mounted in the hollow interior region (10) of the housing (4) on the first vibration damping mounting means (16).

30. Apparatus as claimed in Claim 29 characterised in that the disc drive (2) is a hard disc drive (2).

31. A computer comprising a computer cabinet and a disc drive (2) mounted in the computer cabinet, characterised in that the apparatus (1) according to any preceding claim is mounted within the computer cabinet, and the disc drive (2) is mounted in the hollow interior region (10) of the housing (4) of the apparatus (1) on the first vibration damping mounting means (16).

32. A method for damping the transmission of audible noise generated by a disc drive (2) of a computer or other computer

type device, characterised in that the method comprises the steps of placing the disc drive (2) in a hollow interior region (10) of a substantially closed housing (4) with the disc drive (2) mounted on first vibration damping mounting means (16) within the hollow interior region (10), and spaced apart from an inner surface (11) of the housing (4) defining the hollow interior region (10), and circulating a fluid medium in the hollow interior region (10) of the housing (4) for transferring heat from the disc drive (2) to the housing (4).

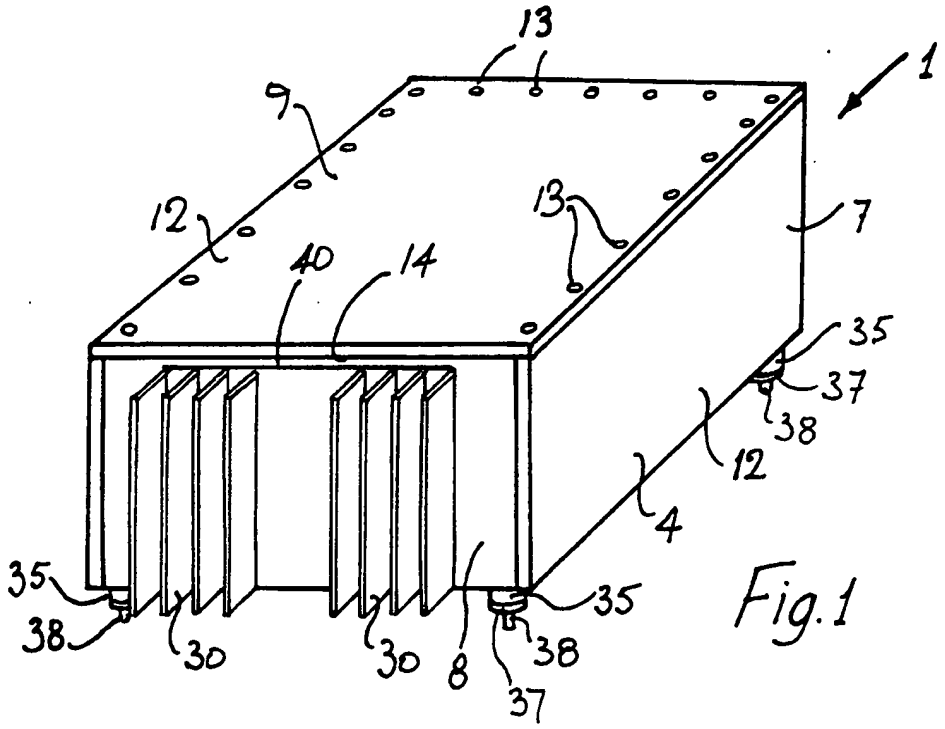
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Fig. 1

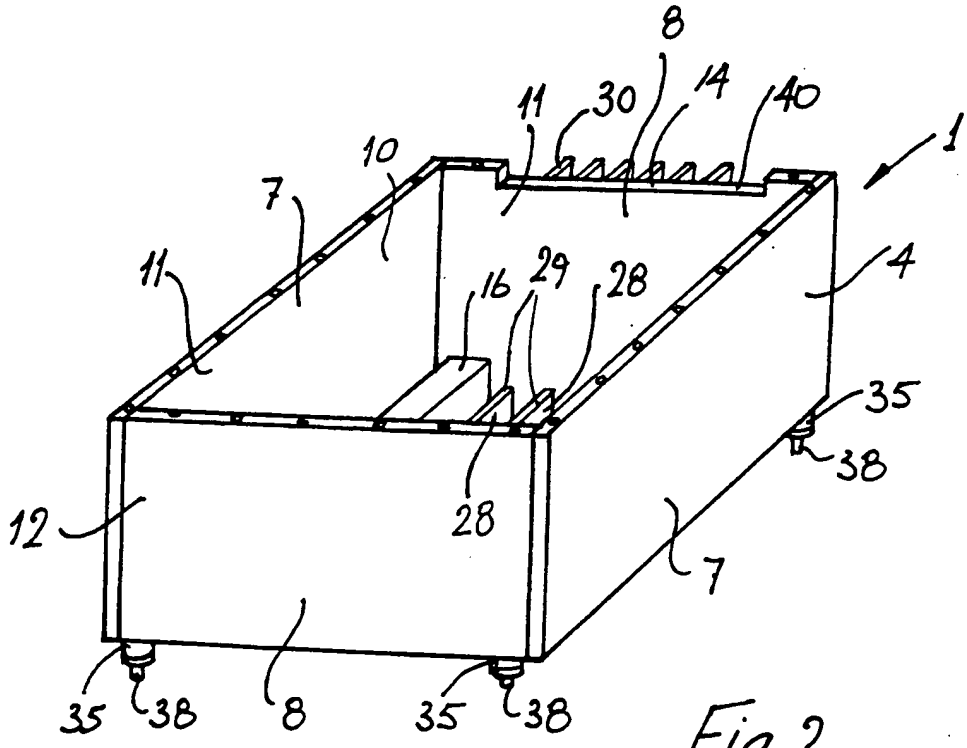
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Fig. 2

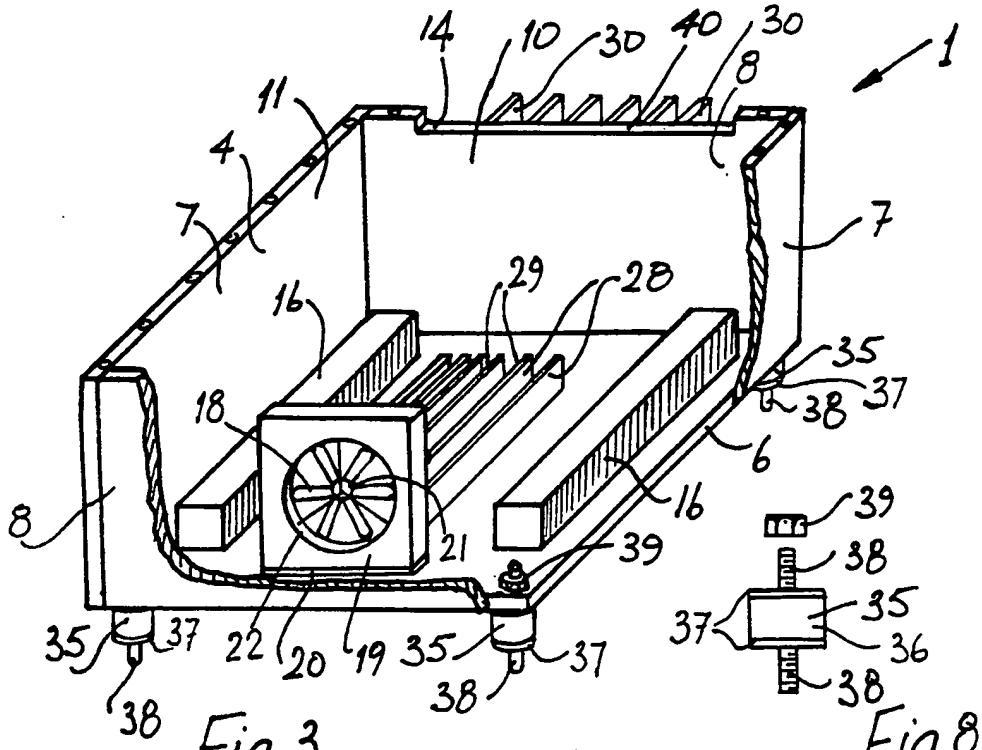

Fig. 3

Fig. 8

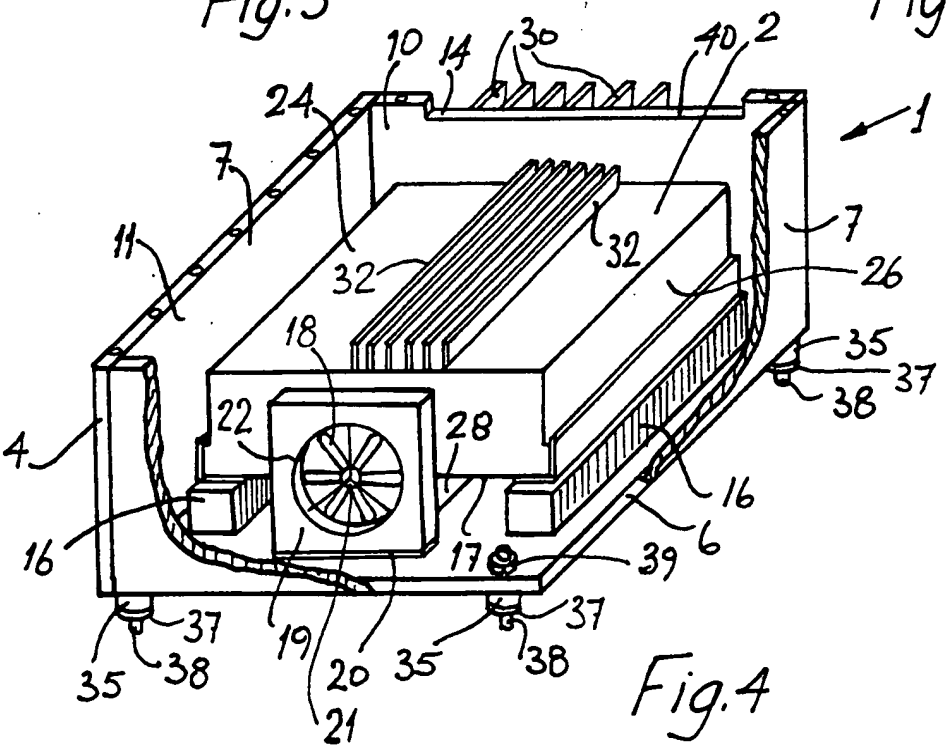

Fig. 4

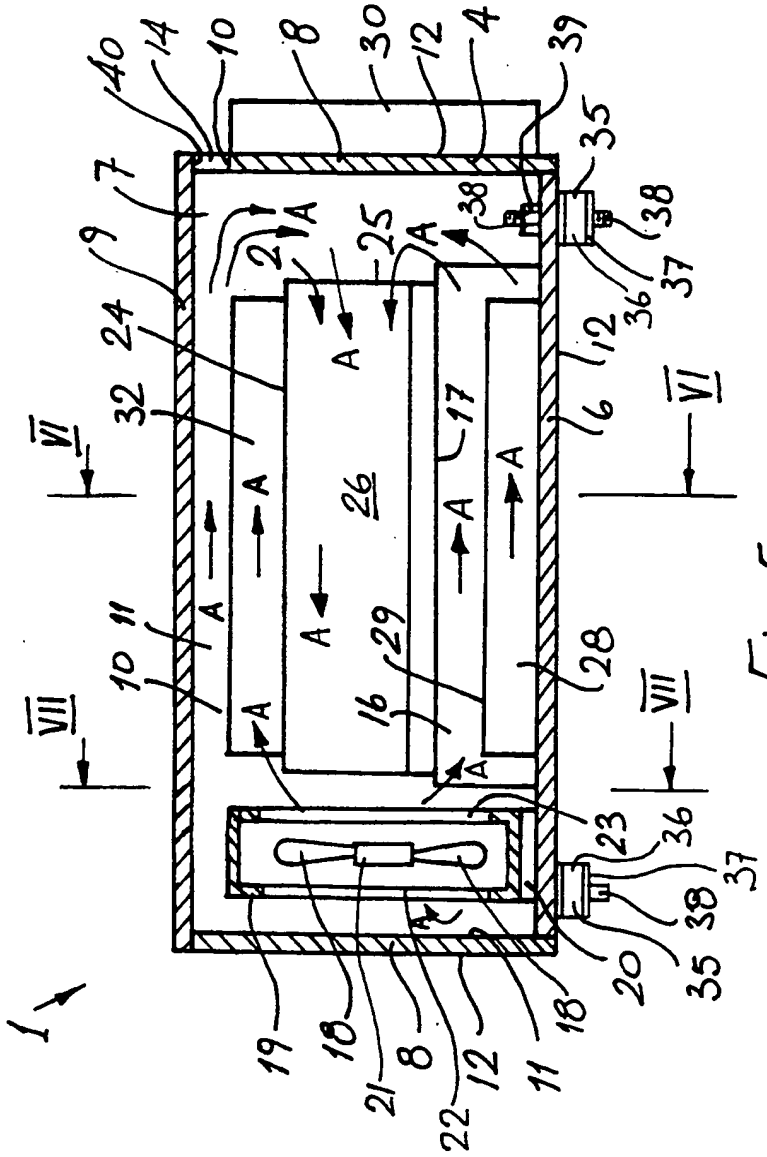
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Fig. 5

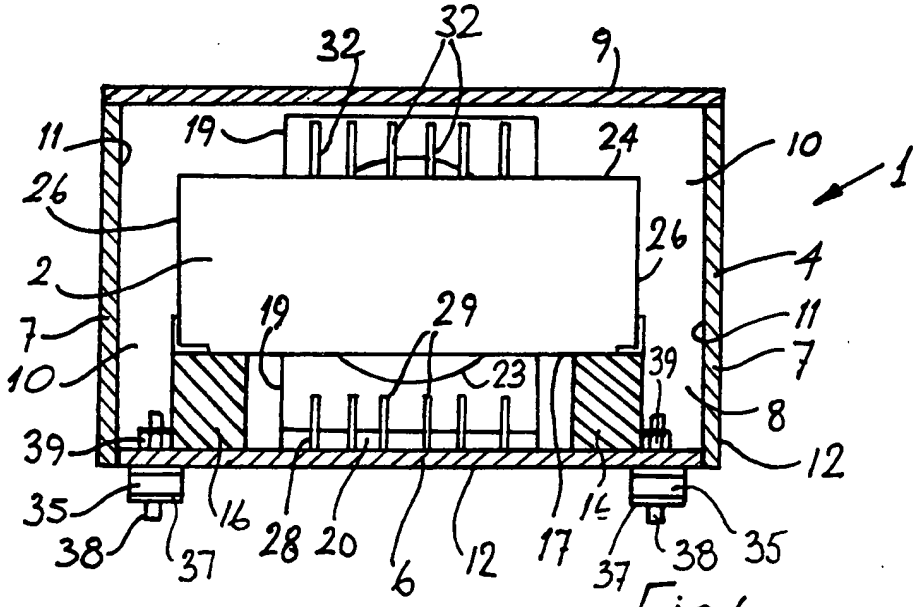
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Fig. 6

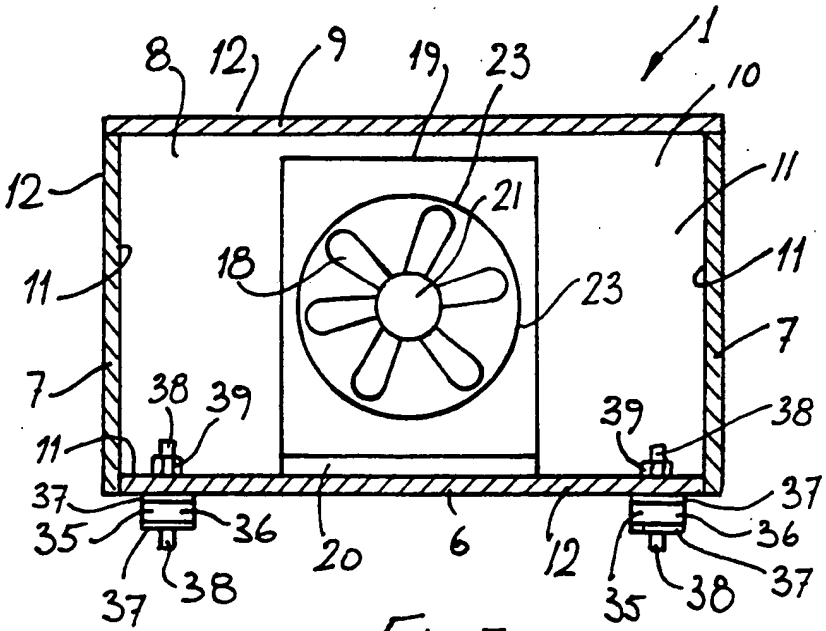
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Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No PCT/IE 93/00032

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G11B33/14

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G11B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 465 153 (CANON K.K.) 8 January 1992 see column 4, line 44 - column 5, line 23; . figure 3	1,32
X	DE,A,4 118 762 (MITSUBISHI DENKI K.K.) 19 December 1991 see column 3, line 12 - line 66; figures 2,4	1-10,32
X	DE,A,4 124 089 (HITACHI) 23 January 1992 see column 2, line 23 - column 3, line 20; figures 2,6-9	1,12-15, 18,32
X	GB,A,2 242 304 (BROADGATE LIMITED) 25 September 1991 see page 5, line 15 - line 24 see page 7, line 7 - line 24; figures 1-3	1,4,16, 17,19

-/--

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 AUGUST 1993	09. 09. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	RESSENAAR J.P.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A,4 926 291 (SARRAF) 15 May 1990 see abstract; claims 12,13; figure 1	1,5-10, 19,26-30
A	WO,A,9 005 982 (MAXTOR CORPORATION) 31 May 1990 see page 10, paragraph 2 - page 13, paragraph 3; figures 2-5	1,13-15
A	EP,A,0 341 957 (FUJITSU LIMITED) 15 November 1989 see column 3, line 11 - line 55; figures 1,4-8	1,13-15, 28-30
A	WO,A,8 704 557 (LINN PRODUCTS LIMITED) 30 August 1987 see page 2, line 5 - line 24; figure 1	1,15

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

IE 9300032
SA 74332

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0465153	08-01-92	JP-A- 4067386	03-03-92
DE-A-4118762	19-12-91	GB-A- 2245752	08-01-92
DE-A-4124089	23-01-92	JP-A- 4212770	04-08-92
GB-A-2242304	25-09-91	None	
US-A-4926291	15-05-90	None	
WO-A-9005982	31-05-90	US-A- 4980786	25-12-90
		AU-A- .4626689	12-06-90
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		US-A- 5079655	07-01-92
WO-A-8704557	30-08-87	EP-A- 0255822	17-02-88
		JP-T- 63502383	08-09-88

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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IBM Technical Disclosure Bulletin Vol. 40 No. 12 December 1997

Frictionally Constrained Shock Isolator for Direct Access Storage Device

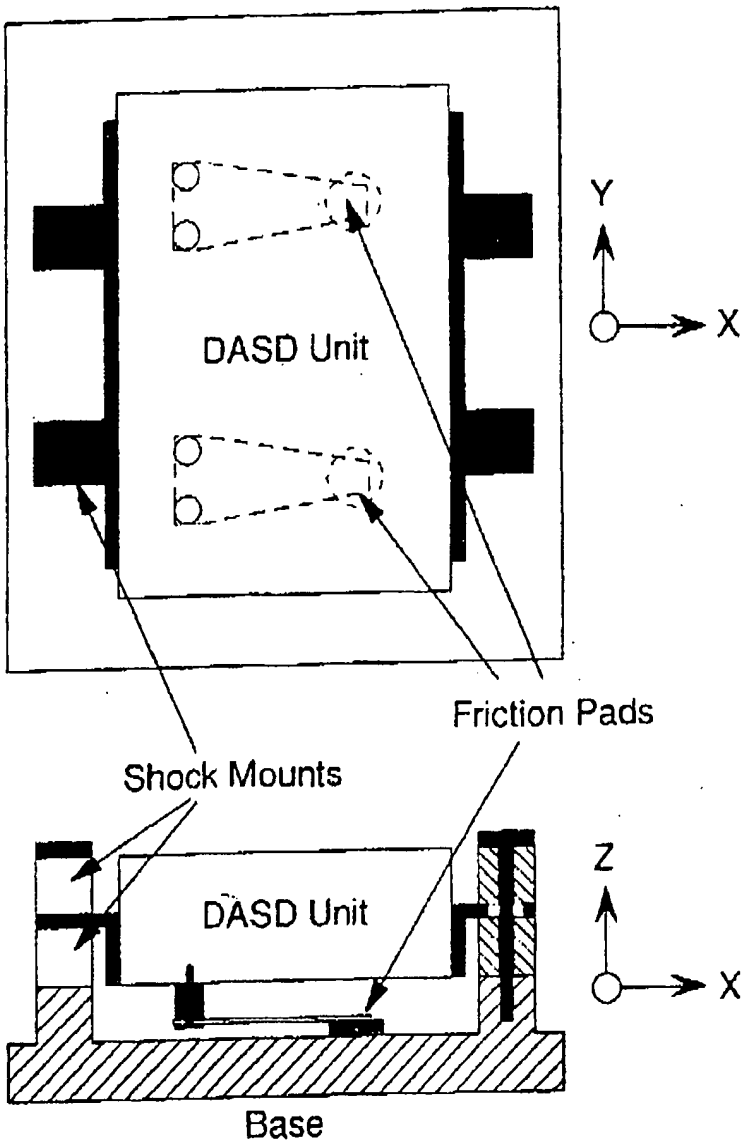
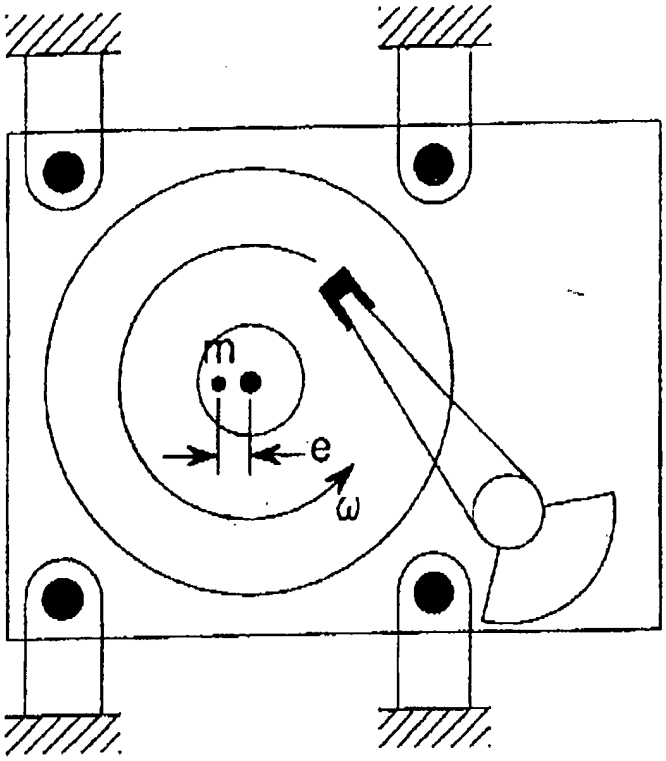


Fig. 1 Use of Frictional Pads to Limit Self-Induced Vibrations

Disclosed is a device of frictional pads which is used to constrain small motions that are induced by the internal vibrations of an operating Direct Storage Access Device (DASD), without hampering the large motions needed by soft shock isolators to attenuate large input shocks. This device allows an increase in shock protection without impacting DASD performance.



- Harmonic Force by Spindle = $m.e.\omega^2$
- Worst case Friction needed to suppress vibration for n friction pads..... $n.F = m.e.\omega^2$
- Each Friction Interface must support at least $\frac{m.e.\omega^2}{n}$ level of force.

Fig. 2 Design Criterion for Friction-Pad Damping

Small form factor DASDs are being used in a variety of portable applications, the most common of which is laptop computers. Some other applications which are becoming increasingly popular are personal storage devices (which are portable, externally attached hard drives) and removable storage for digital video cameras. The DASDs used in these environments have to be able to withstand high shock loads in the event they are mishandled or dropped. To reduce the input shocks from such abuse to values for which their internal components can be designed to withstand, the DASDs are generally provided with shock isolation via some form of compliant

mount between it and its enclosure. The more compliant the mount, the greater the shock isolation that can be provided.

Unfortunately, along with increasing the compliance, comes the problem of increasing Track-Mis-Registration (TMR). It is caused by angular vibrations in the DASD unit which make it more difficult for the actuator servo system to keep the head on track. Such vibrations are mostly due to mass imbalances in the moving parts of the DASD or its reaction to actuator motion. The softer the mounts, the greater the vibration and the worse the TMR. Thus, there is a limit to how compliant the mounts can be made and the degree of shock isolation that can be provided.

This device proposes the use of frictional pads between the DASD unit and its enclosure to solve the problem of TMR. One arrangement for such pads is shown in Fig. 1. The pads provide a mechanical coupling between the unit and the base in parallel to that already provided by the shock mounts/isolators.

The pad, made out of a suitable friction material, is attached to the apex of a tapering lever arm, the other end of which being rigidly attached to the DASD unit. The arm, made out of a spring material, loads the pad against a suitable flat surface on the base. Due to the triangular shape and thin cross-section, the arm can deflect easily only in the vertical or Z direction and is very stiff in the horizontal or X-Y directions. Hence, all motions of the DASD unit in the horizontal plane are restricted until the forces exceed the frictional force between the pads and the base and cause relative sliding.

The design of the preload for the pads has to be such that the frictional forces are greater than those created by the self induced vibrations. The criterion for this is shown in Fig. 2. When this is satisfied, the pads will act as a rigid coupling between the DASD unit and the base and hence suppress any vibrations. In the event of a high level shock, the forces on the pads will far exceed the frictional force so that the pads will slide relative to the base. The shock will thus be channelled through the shock mounts/isolators and get suitably attenuated. The design of the pad/arm assembly, the number deployed, and the arrangement in which deployed can all be varied to satisfy the various needs of the designer or user.